What is Claimed:

1. An electrically-pumped terahertz (THz) frequency radiation source comprising:

an optical gain material formed substantially of at least one group IV element and doped with at least one dopant having an intra-center transition frequency in a range of about 0.3THz to 30THz;

a first electrode electrically coupled to the optical gain material; and

a second electrode electrically coupled to the optical gain material.

2. The electrically-pumped THz frequency radiation source of claim 1, wherein the optical gain material includes at least one of:

a crystalline material formed of one group IV element;

a crystalline material formed of an alloy of group IV elements; or

an amorphous material formed of a group IV element.

3. The electrically-pumped THz frequency radiation source of claim 1, wherein the optical gain material is selected from a group consisting of: diamond, crystalline silicon, crystalline germanium, crystalline silicon carbide, crystalline silicon germanium, polycrystalline silicon, amorphous diamond, amorphous silicon, and amorphous germanium.

4. The electrically-pumped THz frequency radiation source of claim 1, wherein the at least one dopant is one of a group III element or a group V element.

5. The electrically-pumped THz frequency radiation source of claim 1, wherein the at least one dopant is a shallow depth dopant.

6. The electrically-pumped terahertz frequency radiation source of claim 1, wherein the at least one dopant is selected from a group consisting of: boron, phosphorus, gallium, antimony, arsenic, and aluminum.

7. The electrically-pumped THz frequency radiation source of claim 1, wherein:

the at least one dopant includes a first co-dopant of a first carrier type and a second co-dopant of a second carrier type to compensate the first co-dopant; and

a first dopant concentration of the first co-dopant is at least five times a second dopant concentration of the second co-dopant.

8. The electrically-pumped THz frequency radiation source of claim 1, wherein:

the at least one dopant includes;

a first co-dopant of a first carrier type having a first intra-center transition frequency; and

a second co-dopant of the first carrier type having a second intra-center transition frequency;

a first dopant concentration of the first co-dopant is approximately equal to a second co-dopant concentration of the second dopant; and

the first intra-center transition frequency is not equal to the second intra-center transition frequency.

9. The electrically-pumped THz frequency radiation source of claim 1, wherein a resistivity of the optical gain material is in the range of about 1 to 10 ohm-cm.

10. The electrically-pumped THz frequency radiation source of claim 1, wherein:

the first electrode is formed of at least one of aluminum, gold, silver, copper, nickel, titanium, tungsten, platinum, germanium, polyaniline, or polysilicon; and

the second electrode is formed of at least one of aluminum, gold, silver, copper, nickel, titanium, tungsten, platinum, germanium, polyaniline, or polysilicon.

11. The electrically-pumped THz frequency radiation source of claim 1, wherein the first electrode forms a Schottky barrier contact with the optical gain material.

12. The electrically-pumped THz frequency radiation source of claim 1, wherein the first electrode forms a substantially ohmic contact with the optical gain material.

13. The electrically-pumped THz frequency radiation source of claim 1, further comprising:

a first reflective element and a second reflective element substantially parallel to the first reflective element, the first reflective element and the second reflective element being arranged on either side of the optical gain material to form a Fabry-Perot laser cavity;

wherein;

a reflectivity of the first reflective element is less than 100%; and

the electrically-pumped THz frequency radiation source emits coherent THz frequency radiation through the first reflective element.

14. The electrically-pumped THz frequency radiation source of claim 1, wherein the optical gain material is coupled to a substrate.

15. The electrically-pumped THz frequency radiation source of claim 14, wherein:

the substrate includes a distributed feedback element;

the distributed feedback element is optically coupled to the optical gain material; and

the electrically-pumped THz frequency radiation source emits coherent THz frequency radiation.

16. The electrically-pumped THz frequency radiation source of claim 1, wherein the optical gain material is formed as a doped region within a substantially undoped material formed substantially of at least one group IV element.

17. A method of manufacturing a terahertz (THz) frequency radiation source comprising the steps of:

a) providing an optical gain material formed substantially of at least one group IV element and doped with at least one dopant having an intra-center transition frequency in a range of about 0.3THz to 30THz;

b) forming a first electrode electrically coupled to the optical gain material; and

c) forming a second electrode electrically coupled to the optical gain material.

18. The method of claim 17, wherein step (a) includes the step of:

a1) providing a wafer formed substantially of the at least one group IV element and doped with the at least one dopant;

a2) dicing the wafer to form a plurality of diced wafer pieces; and

a3) selecting one piece of the plurality of diced wafer pieces as the optical gain material.

19. The method of claim 17, wherein step (b) includes depositing a metal on a first surface portion of the optical gain material to form a Schottky barrier contact.

20. The method of claim 17, wherein step (b) includes:

b1) increasing a dopant concentration of a first surface portion of the optical gain material; and

b2) depositing a conductive material on the first surface portion of the optical gain material to form a substantially ohmic contact.

21. The method of claim 17, wherein:

forming the first electrode in step (b) includes at least one of;

sputtering conductive material onto a first surface portion of the optical gain material;

depositing conductive material onto the first surface portion of the optical gain material by vaporization deposition; or

depositing conductive material onto the first surface portion of the optical gain material by evaporation deposition; and

forming the second electrode in step (c) includes at least one of;

sputtering conductive material onto a second surface portion of the optical gain material;

depositing conductive material onto the second surface portion of the optical gain material by vaporization deposition; or

depositing conductive material onto the second surface portion of the optical gain material by evaporation deposition.

22. A method of manufacturing a terahertz (THz) frequency radiation source comprising the steps of:

a) providing a substrate;

b) depositing a optical gain material layer on the substrate, the optical gain material layer formed substantially of at least one group IV element and doped with at least one dopant having an intra-center transition frequency in a range of about 0.3THz to 30THz;

c) forming a first electrode electrically coupled to the optical gain material layer; and

d) forming a second electrode electrically coupled to the optical gain material layer.

23. The method of claim 22, wherein depositing the optical gain material layer in step (b) includes at least one of:

sputtering optical gain material onto the substrate;

depositing the optical gain material onto the substrate by vaporization deposition;

depositing the optical gain material onto the substrate by evaporation deposition; or

epitaxially growing the optical gain material on the substrate.

24. A method of manufacturing a terahertz (THz) frequency radiation source comprising the steps of:

a) providing a substantially undoped material formed substantially of at least one group IV element;

b) doping at least a portion of the substantially undoped material with at least one dopant having an intra-center transition frequency in a range of about 0.3THz to 30THz to form an optical gain material region;

c) forming a first electrode electrically coupled to the optical gain material region; and

d) forming a second electrode electrically coupled to the optical gain material region.

25. The method of claim 24, wherein doping the portion of the substantially undoped material in step (b) includes at least one of:

diffusing the at least one dopant into the portion of the substantially undoped material;

ion implanting the at least one dopant into the portion of the substantially undoped material.

26. An electrically-pumped terahertz (THz) frequency radiation detector comprising:

an optical absorption material formed substantially of at least one group IV element and doped with at least one dopant having an intra-center transition frequency in a range of about 0.3THz to 30THz;

a first electrode electrically coupled to the optical absorption material; and

a second electrode electrically coupled to the optical absorption material.

27. A method of manufacturing a terahertz (THz) frequency radiation detector comprising the steps of:

a) providing an optical absorption material formed substantially of at least one group IV element and doped with at least one dopant having an intra-center transition frequency in a range of about 0.3THz to 30THz;

b) forming a first electrode electrically coupled to the optical absorption material; and

c) forming a second electrode electrically coupled to the optical absorption material.

28. A method of manufacturing a terahertz (THz) frequency radiation detector comprising the steps of:

a) providing a substrate;

b) depositing an optical absorption material layer on the substrate, the optical absorption material layer formed substantially of at least one group IV element and doped with at least one dopant having an intra-center transition frequency in a range of about 0.3THz to 30THz;

c) forming a first electrode electrically coupled to the optical absorption material layer; and

d) forming a second electrode electrically coupled to the optical absorption material layer.

29. A method of manufacturing a terahertz (THz) frequency radiation detector comprising the steps of:

a) providing a substantially undoped material formed substantially of at least one group IV element;

b) doping at least a portion of the substantially undoped material with at least one dopant having an intra-center transition frequency in a range of about 0.3THz to 30THz to form an optical absorption material region;

c) forming a first electrode electrically coupled to the optical absorption material region; and

d) forming a second electrode electrically coupled to the optical absorption material region.